BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B29C 57/04, B29B 13/02 // B29K 227:06

A1

(11) International Publication Number: WO 97/33739

(43) International Publication Date: 18 September 1997 (18.09.97)

(21) International Application Number: PCT/NL97/00117

(22) International Filing Date: 10 March 1997 (10.03.97)

(30) Priority Data:
1002604 13 March 1996 (13.03.96) NL

(71) Applicant *(for all designated States except US)*: WAVIN B.V. [NL/NL]; Stationsplein 3, NL-8011 CW Zwolle (NL).

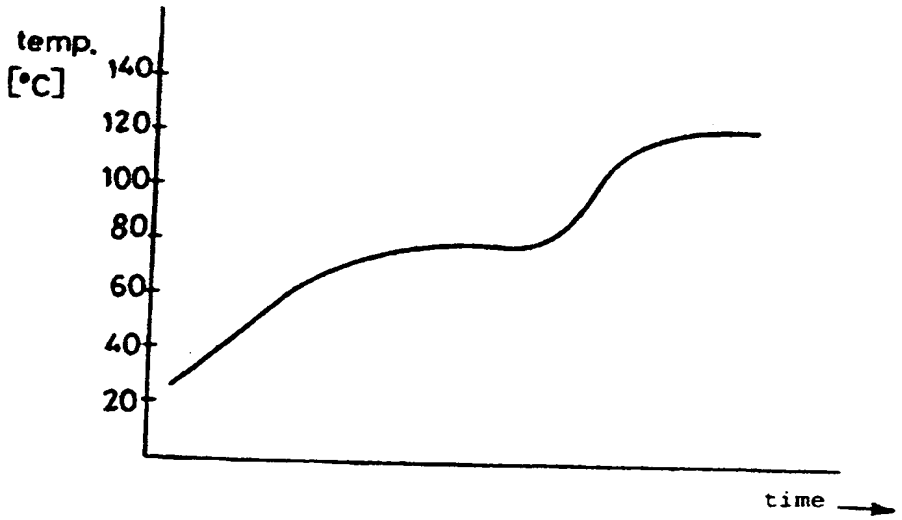
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: VISSCHER, Jan [NL/NL]; Dedemvaartseweg N.92, NL-7775 AK Lutten (NL).

(74) Agent: BROOKHUIS, H., J., A.; Van Exter Polak & Charlouis B.V., P.O. Box 3241, NL-2280 GE Rijswijk (NL).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: METHOD FOR FORMING A SOCKET ON A PIPE OF BIAXIALLY ORIENTED POLYVINYL CHLORIDE



(57) Abstract

The method comprises the successive steps of: placing a support in an end section of the pipe, heating the pipe in the region of the end section; deforming the pipe to produce a socket in the region of the heated end section; the heated end section being supported internally while the socket is being formed; cooling the pipe in the region of the end section, the end section being supported internally during the cooling operation; and removing the support from the pipe, for the purpose of heating the internally supported end section of the pipe, said end section first being heated until said end section has reached, substantially homogeneously, the glass transition temperature of polyvinyl chloride and then being further heated until the end section has reached, substantially homogeneously, a temperature near, preferably just above, the orientation temperature of polyvinyl chloride.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	**GB**	United Kingdom	**MW**	Malawi
AT	Austria	**GE**	Georgia	**MX**	Mexico
AU	Australia	**GN**	Guinea	**NE**	Niger
BB	Barbados	**GR**	Greece	**NL**	Netherlands
BE	Belgium	**HU**	Hungary	**NO**	Norway
BF	Burkina Faso	**IE**	Ireland	**NZ**	New Zealand
BG	Bulgaria	**IT**	Italy	**PL**	Poland
BJ	Benin	**JP**	Japan	**PT**	Portugal
BR	Brazil	**KE**	Kenya	**RO**	Romania
BY	Belarus	**KG**	Kyrgystan	**RU**	Russian Federation
CA	Canada	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SG**	Singapore
CH	Switzerland	**KZ**	Kazakhstan	**SI**	Slovenia
CI	Côte d'Ivoire	**LI**	Liechtenstein	**SK**	Slovakia
CM	Cameroon	**LK**	Sri Lanka	**SN**	Senegal
CN	China	**LR**	Liberia	**SZ**	Swaziland
CS	Czechoslovakia	**LT**	Lithuania	**TD**	Chad
CZ	Czech Republic	**LU**	Luxembourg	**TG**	Togo
DE	Germany	**LV**	Latvia	**TJ**	Tajikistan
DK	Denmark	**MC**	Monaco	**TT**	Trinidad and Tobago
EE	Estonia	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**UG**	Uganda
FI	Finland	**ML**	Mali	**US**	United States of America
FR	France	**MN**	Mongolia	**UZ**	Uzbekistan
GA	Gabon	**MR**	Mauritania	**VN**	Viet Nam

Method for forming a socket on a pipe of biaxially oriented polyvinyl chloride.

The invention relates to a method for forming a socket on a pipe of biaxially oriented polyvinyl chloride according to the preamble of claim 1.

Such a method is disclosed by NL-A-9400894. The pipe of biaxially oriented polyvinyl chloride may, for example, have been fabricated by means of the methods as described in WO 95/25627, WO 95/25628 and WO 95/30533.

In the case of the method disclosed by NL-A-9400894, an end section of the pipe on which the socket is to be formed, is slipped onto a support section of a mandrel, which support section fits into the pipe. Then the internally supported pipe end section is heated, whereupon a socket-forming mandrel section which adjoins the support section and whose shape substantially corresponds to the intended shape of the socket is forced into the heated end section of the pipe. Finally, the pipe end section still supported by the mandrel is cooled.

It was found that in the case of pipes on which sockets had been formed by means of the known method, cracking occurred in a large number of cases in the socket section of the pipes. These cracks sometimes occurred even while the sockets were being formed, but also if the sockets were subsequently subjected to an impact load.

It is an object of the present invention to provide a method which will afford sockets of better quality.

The present invention provides a method according to the preamble of claim 1, which is characterized in that, for the purpose of heating the internally supported end section of the pipe, said end section is first heated until said end section has reached, substantially homogeneously, the glass transition temperature of polyvinyl chloride and is then further heated until the end section has reached, substantially homogeneously, a temperature near, preferably just above, the orientation temperature of polyvinyl

chloride.

In other words, the invention therefore proposes that the relevant internally supported end section of the pipe be heated in at least two steps: first to about the glass transition temperature of polyvinyl chloride, which is at 80 - 85 °C, said heating being maintained for a sufficiently long period to ensure that the end section, as seen across the wall thickness, virtually uniformly is at this temperature, and in one or more subsequent steps to a higher temperature which is in the vicinity of the orientation temperature, which is about 110 °C, and preferably to a value somewhat above the orientation temperature, for example to about 120 °C.

Preferably, the heating of the pipe in the region of the end section comprises the external heating of the pipe and/or the heating of the support.

The heating means may comprise a heating ring, for example including an infrared radiator, which is situated around the support section of the mandrel, if this has first been inserted into the pipe. The heat output of such a heating ring to the pipe can be controlled in a simple and accurate manner.

The invention will be explained hereinafter in more detail with reference to the drawing, in which:

Figure 1 shows a schematic longitudinal section of an illustrative embodiment of an apparatus for forming a socket on a biaxially oriented pipe during the initial phase of the method according to the invention,

Figure 2 shows a view corresponding to Figure 1 during the end phase of the method according to the invention, and

Figure 3 shows the variation with time of the temperature of the internally supported end section of the pipe during the heating operation in the manner according to the invention.

The following description starts from a previously fabricated pipe of biaxially oriented polyvinyl chloride having a smooth, cylindrical wall, which is to be provided with a socket.

The apparatus 10 shown in Figures 1 and 2 enables a socket to be formed on a biaxially oriented pipe 11, the socket being provided directly with an elastic sealing ring 12.

The apparatus 10 comprises a hollow cylindrical mandrel 13 which is open at one end. The mandrel 13 has a support section 14, a transition section 15 and a socket-forming section 16. The socket-forming section 16 is provided with a circumferential groove 17 on the outside. The apparatus 10 further comprises a support ring 18 which can slide over the socket-forming section 16. For the purpose of heating and subsequent cooling of the end section of the pipe 11 to be processed, the apparatus comprises a heating device 20 and a cooling device 22.

The fabrication of a socket with sealing ring by means of the apparatus shown in Figures 1 and 2 proceeds as follows. First the sealing ring 12 is pushed over the mandrel 13 until it comes to lie in the relatively shallow groove 17, the support ring 18 bearing against that side of the sealing ring 12 which faces away from the insertion side of the mandrel 13. Then the support section 14 is inserted, for example by a double-acting hydraulic cylinder (not shown), into the end section of the pipe 11.

When the end section of the pipe 11 is supported internally by the support section 14 of the mandrel 13, said pipe end section is heated by means of the heating device 20. If required it is possible, via the support section 14 of the mandrel 13, to effect internal heating of the end section of the pipe 11. The internal support by the support section 14 prevents shrinkage, in a radial direction, of the pipe 11 whose plastic material, under the influence of the heating, is trying to revert to the state of the plastic material prior to being oriented biaxially. Some shrinkage in the heated end section does occur in the axial direction. This axial shrinkage of the end section is advantageous, however, because it is thus possible to compensate for the wall becoming thinner in the socket region as a result of the radial expansion yet to be effected.

When the end section of the pipe 11 has been suitably heated, the mandrel 13 is pushed further into the pipe 11. At the moment when the sealing ring 12 comes up against the pipe 11, the pipe 11 will be further expanded by the sealing ring 12. The sealing ring 12 is supported, in the process, by the support ring 18 which moves in tandem with the mandrel 13. As a result, the pipe 11 slides over the sealing ring 12 and subsequently over the support ring 18 situated behind it. As soon as the intended position of the socket-forming section 16 in the tube 11 has been reached, the support ring 18 is drawn backwards out of the pipe 11, by means which are likewise not shown, to the position shown in Figure 2. Because the biaxially oriented pipe 11 is still warm and therefore has a tendency to shrink in a radial direction, the pipe 11 automatically comes to lie, in the state shown in Figure 2, against the socket-forming section 16 and then traps the sealing ring 12. Then the end section, still internally supported, of the pipe 11 can be cooled by means of the cooling device 22 and/or by cooling the mandrel 13. Finally, the mandrel 13 can be pulled from the pipe 11 in its entirety, the sealing ring 12 disengaging from the shallow groove 17 of the mandrel 13 and remaining behind in the socket formed.

The present invention provides for a special manner of heating the end section, internally supported by the support section 14, of the pipe 11. The variation in temperature against time, as preferentially aimed for, of the end section of the pipe 11 is shown in Figure 3. In the first instance, the heating device 20 is set so as to reach an end section temperature which roughly corresponds to the glass transition temperature of polyvinyl chloride (about 80-85 °C). This setting of the heating device 20 is maintained for some time, to ensure that the end section of the pipe 11 is at this temperature as uniformly as possible. Only when it can be assumed that this is the case is the heating device 20 set so as to heat the end section of the pipe 11 to a higher temperature. The temperature ultimately to be reached for the end section of the pipe 11 preferably roughly corresponds, according to the invention,

to the orientation temperature of polyvinyl chloride (about 110 °C), preferably slightly above, for example 120 °C.

For that matter, once the end section of the pipe 11 has been heated uniformly to the glass transition temperature, it is important, when the end section is heated to a higher temperature, that the temperature differences in the wall of the end section of the pipe 11 be kept within limits. This can be done by the end section being heated stepwise, so that the end section will first uniformly have reached a particular temperature and will only then be heated further once more. Thus it is even possible for the end section to be heated to a higher temperature than is preferable according to the invention, for example to about 135 - 140 °C. If the end section were to be heated in one step from the glass transition temperature to such a high temperature, the probability of cracking is high.

Although the mechanism involved is not entirely clear, the abovedescribed manner of heating is found to avoid the inception of undesirable stresses in the socket, which lead to cracking.

It is evident that in the process of forming the socket by the method according to the present invention, other mandrel designs may alternatively be used. One possibility, for example, is that of a radially expandable mandrel.

CLAIMS

1. Method for forming a socket on a pipe of biaxially oriented polyvinyl chloride, comprising the successive steps of:

- placing a support in an end section of the pipe,
- heating the pipe in the region of the end section,
- deforming the pipe to produce a socket in the region of the heated end section, the heated end section being supported internally while the socket is being formed,
- cooling the pipe in the region of the end section, the end section being supported internally during the cooling operation, and
- removing the support from the pipe,

characterized in that:

- for the purpose of heating the internally supported end section of the pipe, said end section is first heated until said end section has reached, substantially homogeneously, the glass transition temperature of polyvinyl chloride and is then further heated until the end section has reached, substantially homogeneously, a temperature near, preferably just above, the orientation temperature of polyvinyl chloride.

2. Method according to claim 1, wherein the placing of a support in the end section of the pipe comprises a support section of a rigid mandrel being inserted into the end section, and

- the deformation of the pipe to produce a socket in the region of the end section comprises a socket-forming section, which adjoins the support section, of the rigid mandrel being forced into the pipe.

3. Method according to claim 1 or 2, wherein the heating of the pipe in the region of the end section comprises the external heating of the pipe and/or the heating of the support.

4. Method according to one or more of the preceding claims, wherein the cooling of the pipe in the region of the end section comprises the external cooling of the pipe

and/or the cooling of the support.

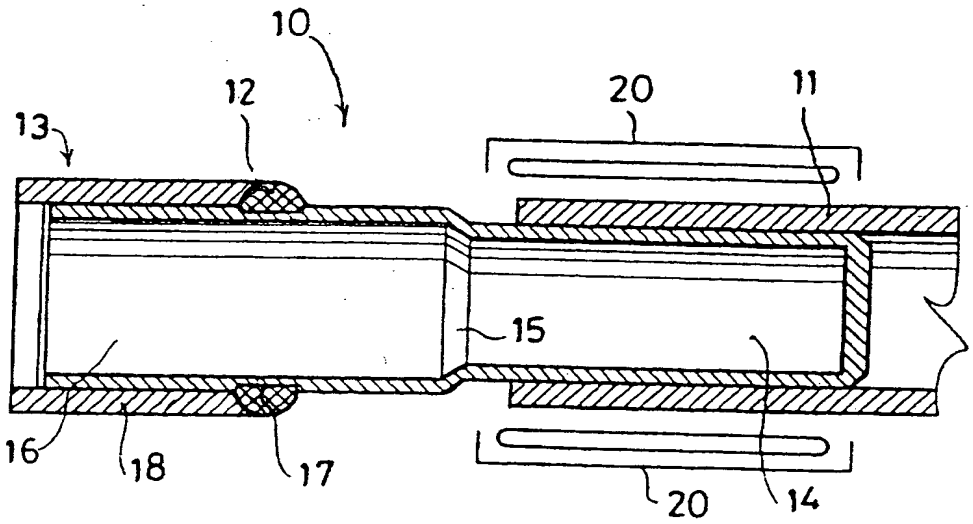


Fig. 1.

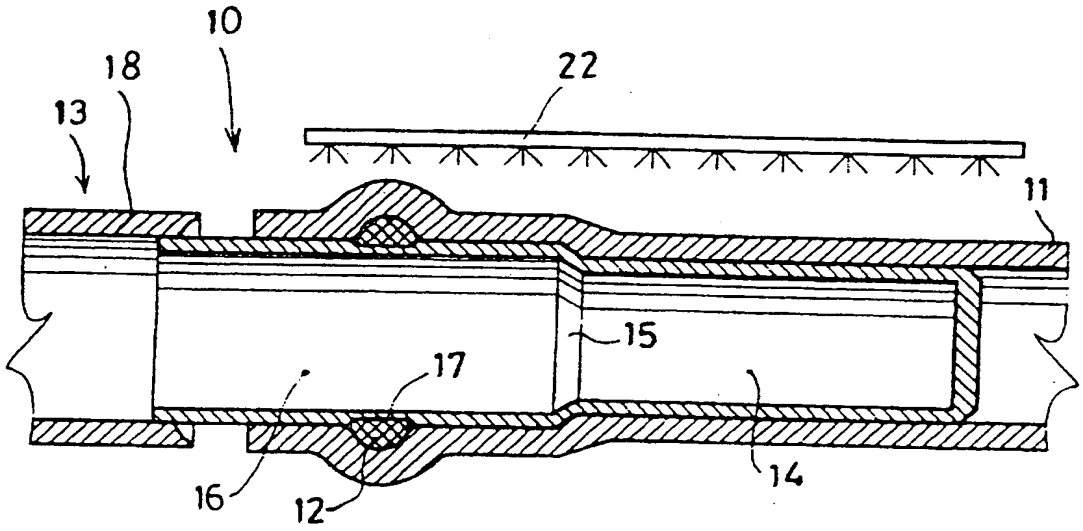


Fig. 2.

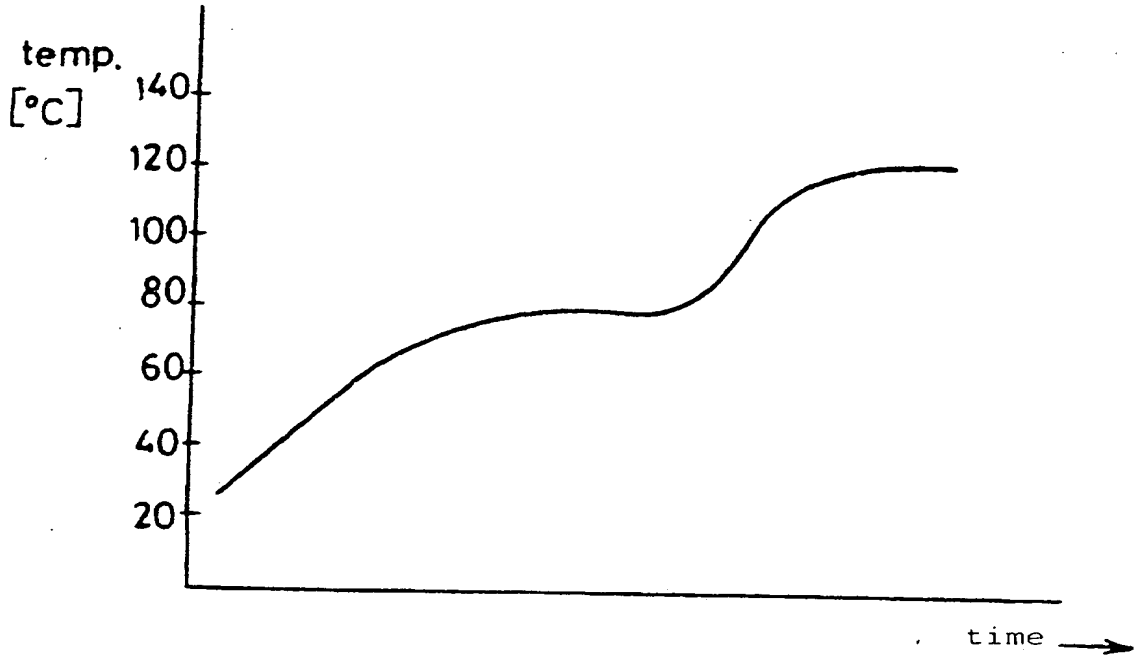


Fig. 3.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 97/00117

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C57/04 B29B13/02 //B29K227:06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NL 9 400 894 A (WAVIN BV) 2 January 1996 cited in the application see page 4, line 9 - line 30 see figures	1-4
A	US 4 276 010 A (SHARTZER KENNETH B) 30 June 1981 see column 3, line 23 - line 51 see figures	1
A	US 4 255 137 A (GUYER NATHAN E) 10 March 1981 see abstract see column 3, line 63 - line 65	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 May 1997	- 3. 06. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Lanaspeze, J

Form PCT ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int onal Application No
PCT/NL 97/00117

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
NL 9400894 A	02-01-96	NONE	
US 4276010 A	30-06-81	NONE	
US 4255137 A	10-03-81	CA 1129741 A	17-08-82